

**Small Business Innovation Research (SBIR) and
Small Business Technology Transfer (STTR)
Opportunity Announcement
HR001120S0019-07
Compact Modular Detector for Water and Food Contaminants**

Which program will fund this topic?

SBIR

What type of proposals will be accepted?

Direct to Phase II (DP2) Only

Technology Area(s): Chemical/Biological Defense, Human Systems

DARPA Program: Biological Robustness in Complex Settings (BRICS)

I. INTRODUCTION

The Defense Advanced Research Projects Agency (DARPA) Small Business Programs Office (SBPO) is issuing an SBIR/STTR Opportunity (SBO) inviting submissions of innovative research concepts in the technical domain(s) of Chemical/Biological Defense and Human Systems. In particular, DARPA is interested in understanding the feasibility of a Compact Modular Detector for Water and Food Contaminants.

This SBO is issued under the Broad Agency Announcement (BAA) for SBIR/STTR, HR001120S0019. All proposals in response to the technical area(s) described herein will be submitted in accordance with the instructions provided under HR001120S0019, found here: <https://beta.sam.gov/opp/b8abeb02f16a4450b2c2f859fc00c177/view>.

a. Eligibility

The eligibility requirements for the SBIR/STTR programs are unique and do not correspond to those of other small business programs. Please refer to Section 3.1, Eligible Applicants, of HR001120S0019 for full eligibility requirements.

b. Anticipated Structure/Award Information

Please refer to Section 1, Funding Opportunity Description, provided in HR001120S0019 for detailed information regarding SBIR/STTR phase structure and flexibility.

If a proposer can provide adequate documentation to substantiate that the scientific and technical merit and feasibility described in the Phase I section of the topic has been met and describes the potential commercial applications, the Direct to Phase II (DP2) authority allows the Department of Defense (DoD) to make an award to a small business concern under Phase II of the SBIR program without regard to whether the small business concern was provided an award under Phase I of a SBIR program. This SBO is accepting DP2 proposal submissions.

DARPA will accept DP2 proposals for cost of up to \$2,250,000. This includes a 24-month base period not to exceed a cost of \$1,500,000 and a 12-month option period not

to exceed a cost of \$500,000. A separately priced option of up to \$250,000 must also be proposed for proposers who would like to be considered for participation in the DARPA Embedded Entrepreneur Initiative (EEI). Refer to Section 2.6, DARPA Embedded Entrepreneur Initiative, of HR001120S0019 for detailed information on EEI.

Proposers should refer to Section 4, Application and Submission Information, of HR001120S0019 for detailed proposal preparation instructions. Proposals that do not comply with the requirements detailed in HR001120S0019 and the research objectives of this SBO are considered non-conforming and, therefore, are not evaluated nor considered for award.

DP2 Feasibility Documentation shall not exceed 20 pages. DP2 Technical Proposal shall not exceed 40 pages. Phase II commercialization strategy shall not exceed 5 pages; this should be the last section of the Technical Volume and will not count against the 40-page limit. Please refer to Appendix B of HR001120S0019 for detailed instructions on DP2 proposal preparation.

c. Human Subjects Research (HSR)/Animal Use

Proposers that anticipate involving Human Subjects Research or Animal Use must comply with the approval procedures detailed at <http://www.darpa.mil/work-with-us/additional-baa>. For more information, refer to Section 4.7, Human Subjects/Research/Animal Use, of HR001120S0019.

Proposers are highly encouraged to clearly segregate human and/or animal research testing tasks to allow for partial funding while internal and DoD approvals are being obtained.

d. Evaluation of Proposals

Section 5, Evaluation of Proposals, in HR001120S0019 provides detailed information on proposal evaluation and the selection process for this SBO.

e. Due Date/Time

Full proposal packages (Proposal Cover Sheet, Technical Volume, Price/Cost Volume inclusive of supporting documentation, and Company Commercialization Report) must be submitted via the DoD SBIR/STTR Proposal Submission website per the instructions outlined in HR001120S0019 no later than **2:00 pm ET, June 29, 2020**.

II. TOPIC OVERVIEW

a. Objective

Develop a low-power, compact, and functionally modular device that enables rapid and sensitive detection of chemical and biological contaminants in water and food.

b. Description

Warfighters rely on an array of resources during their deployments, but the availability of safe, uncontaminated water and nutrients is paramount. Despite efforts by the military

to supply troops with safe water and food, operations outside the Continental U.S. (CONUS) require sourcing of these provisions either locally or from nearby regional countries (See References 1 and 2 below). DoD-approved foreign facilities can pose safety risks due to quality control deficiencies and less robust food safety systems (See References 3 (as cited in 1) and 4). Prolonged expeditionary operations can lead to necessarily unsafe practices when warfighters must scavenge for water and foodstuffs from the environment. Besides unintentional or naturally occurring contamination, detecting the purposeful fouling of food or water by adversaries further underscores the need for the technology in this topic.

Currently, field detection of chemicals and pathogens in food and water is accomplished using devices or kits that employ conventional approaches. These include culturing and colony counting, immunological, and polymerase chain reaction-based tests for biological contaminants, and chromogenic/colorimetric or fluorometric chemical tests. Caveats to current technologies vary, but their shortcomings include: inability for a single instrument/kit to detect both chemical and biological targets; inadequate sensitivity and unclear outcomes; and size, weight, and/or power of devices that are untenable for continuous carrying by the Warfighter. Bio-based sensors using cells as contaminant detectors have been under development for some time (See References 5 and 6), and they could have advantages over conventional methods, but the technology needs to be perfected for use in deployed settings.

To ensure warfighters obtain water and food that is safe for consumption, this topic seeks concepts for a low-power, compact, and functionally modular device that enables rapid and sensitive detection of chemical and biological contaminants. This will require integrating developed sensing and reporting technologies into functional prototype devices. Higher consideration will be given to technologies meeting or approaching the following guidelines:

- Function both in-line for continuous assaying of water (at ~ 3 psi) and as dip/swipe sampling from liquids, food surfaces, and suspensions (e.g., milk or yogurt).
- Dimensions not to exceed a total volume of 25 cubic inches and powered by commercially available batteries, with total weight (including batteries) \leq 1 lb.
- Quantitative results provided by direct display or wireless, phone-tethered readout.
- Modular design with capacity to detect numerous targets in different compound classes and biologics through “swappable” sensor arrays.
- Each sensor array should be capable of assaying \geq 135 liters of water plus 100 dips/swipes for a period \geq 7 days.
- Chemical classes of interest include, in order of interest: organophosphates/herbicides/pesticides; perfluorinated compounds; heavy metals (e.g., arsenic, lead, and mercury); and trichloroethylene/tetrachloroethylene. Higher sensitivities to a greater number of chemical contaminants will be preferred.

- Biologic classes of interest include, in order of preference: total coliform, E. coli, Vibrio cholera; parasites (particularly Giardia); and viruses (particularly Norovirus). Higher sensitivities to a greater number of biological contaminants will be preferred.

c. Phase I

To be eligible for Direct to Phase II funding, the company will have satisfied requirements demonstrating Phase I feasibility by building components foundational toward an integrated chemical and biological contaminant biosensor. For evaluation of these criteria, companies must provide the following:

- A report outlining the development, specifications (size, weight, and power (SWaP) and construction details), and current capabilities of component functions for:
 - Contaminant sensing; and
 - Detection reporting.
- Primary data that includes, at a minimum:
 - The list of currently detectable chemical and biological contaminants.
 - Time series data (minimum of 3 replicates) presenting the detection and reporting of each contaminant at varied concentrations down to the limit of detection; contaminants at or near the detection limit should be reported in ≤ 3 h.
 - Information pertinent to production, implementation, and stabilities of the participant sensing and/or reporting biologics.

d. Phase II

This Direct to Phase II program should result in the development and construction of four useable prototypes based on prior work deemed Phase I-equivalent. Depending on the stage of development, prototypes shall be tested against both continuously fed and/or open containers of water, as well as food surfaces and suspensions that are more commonly contaminated with unwanted chemicals or biologics, to prove that the above requirements are met. Based on the results of the Phase II development plan, the small business will develop prototype evaluations phased to increased applicability (i.e., diversity of targets), sensitivity (i.e., reduce detection limit of targets), and functionality (i.e., ability to switch between in-line to dip/swipe sampling) with each successive prototype. These prototypes will be evaluated to determine their capability in meeting the performance goals defined in the Phase II development plan. Evaluation results will be used to refine the prototype into an initial design that will meet requirements stipulated by DARPA. The company will prepare a Phase III development plan to transition the technology to interested DoD organizations. Phase II deliverables will also include monthly status updates and teleconferences, as well as a final report documenting the development of the system, test results compared to the objectives, the technical data package to build the system, and a plan for commercialization.

Schedule/Milestones/Deliverables

Phase II milestones and deliverables for this program should include:

- Month 2: New Capabilities Report that identifies additions and modifications that will be researched, developed, and customized for incorporation into each of four forthcoming prototypes, plus respective semi-annual Demonstration Plan parameters and success metrics for 6-, 12-, 18-, and 24-month demonstrations; plausible steps in capability development include but are not limited to: broader spectrum of and sensitivity to denoted chemical and biological contaminants; ability for alternation between continuous and individual sampling modes; lengthened duration of operation and enhanced system modularity; and improved SWaP, form-factor characteristics, and environmental robustness.
- Month 4: Principal Investigator (PI) meeting presentation material, including demonstration of progress to date with supporting data, PowerPoint presentations of accomplishments and plans, and finalized 6-month Demonstration Plan for Prototype 1 that identifies schedule, location, and any other requirements for this prototype demonstration.
- Month 6: Demonstration of Prototype 1 to DARPA.
- Month 8: Prototype 1 Outcome Report outlining successes, challenges, and necessary modifications towards Prototype 2 development; PI meeting presentation material, including demonstration of progress to date with supporting data, PowerPoint presentations of accomplishments and plans.
- Month 10: PI meeting presentation material, including demonstration of progress to date with supporting data, PowerPoint presentations of accomplishments and plans; finalized 12-month Demonstration Plan for Prototype 2 that identifies schedule, location, and any other requirements for the prototype demonstration.
- Month 12: Demonstration of Prototype 2 to DARPA.
- Month 14: Prototype 2 Outcome Report outlining successes, challenges, and necessary modifications towards Prototype 2 development; PI meeting presentation material, including demonstration of progress to date with supporting data, PowerPoint presentations of accomplishments and plans; identification of military transition partner(s) and other interested DoD organizations (e.g., U.S. Army Natick Soldier Systems Center).
- Month 16: PI meeting presentation material, including demonstration of progress to date with supporting data, PowerPoint presentations of accomplishments and plans; finalized 18-month Demonstration Plan for Prototype 3 that identifies schedule, location, and any other requirements for the prototype demonstration, including observation by military transition partner(s) and other interested DoD organizations.

- Month 18: Demonstration of Prototype 3 to DARPA and potential military transition partners and interested DoD organizations; gather feedback and input from demonstration participants.
- Month 20: Prototype 3 Outcome Report outlining successes, challenges, and necessary modifications towards Prototype 4 development, underscored by responses from interested transition partners, with whom Prototype 4 will be tested in collaboration; PI meeting presentation material, including demonstration of progress to date with supporting data, PowerPoint presentations of accomplishments and plans.
- Month 22: PI meeting presentation material, including demonstration of progress to date with supporting data, PowerPoint presentations of accomplishments and plans; finalized 24-month Demonstration Plan for Prototype 4 that identifies schedule, location, and any other requirements for the prototype demonstration involving testing in conjunction with interested transition partners.
- Month 24: Demonstration of Prototype 4 to DARPA with collaboration by potential military transition partners; gather feedback and input from demonstration participants.
- Months 25-35 (Option): Provision of Prototype 4 Outcome Report, including quantitative metrics on decision making benefits, costs, risks, and schedule for implementation of a final prototype capability based on the demonstration, outlining successes, challenges, and final modifications guided by additional feedback from collaborating transition partners (required by Month 27); should Option period be approved, development and IV&V testing of final target form-factor prototype will initiate concurrently.
- Month 36 (Option): Final prototype delivery and final report and PI meeting presentation material, including specifics of Government or commercial transitions, and any scientific advances that have been achieved under the program. (A brief statement of claims supplemented by publication material will meet this requirement.)

e. Dual Use Applications (Phase III)

Upon completion of a successful Phase II, the company will be expected to support the DoD partner in transitioning the technology for DoD use. The company will develop a compact, modular bio-based chemical and biological contaminant detector for evaluation to determine its effectiveness in an operationally relevant environment. The company will support the DoD partner for test and validation to certify and qualify the system for DoD partner use. This proposed device has a broad capability to support public, private, and commercial food and water safety testing.

f. References

[1] Gulf War Illness and the Health of Gulf War Veterans: Scientific Findings and Recommendations. Research Advisory Committee on Gulf War Veterans' Illnesses.

Washington, D.C.: U.S. Government Printing Office, November 2008

https://www.va.gov/RAC-GWVI/docs/Committee_Documents/GWVIandHealthofGWVeterans_RAC-GWVIReport_2008.pdf

[2] Operation United Assistance: infectious disease threats to deployed military personnel. Murray CK, Yun HC, Markelz AE, Okulicz JF, Vento TJ, Burgess TH, Cardile AP, Miller RS. *Mil Med.* 2015 Jun; 180(6):626-51.
<http://www.idcrp.org/sites/default/files/Murray-2015.pdf>

[3] The impact of infectious diseases on the health of U.S. troops deployed to the Persian Gulf during operations Desert Shield and Desert Storm. Hyams KC, Hanson K, Wignall FS, Escamilla J, Oldfield EC, 3rd. *Clin Infect Dis.* 1995; 20:1497-1504.

[4] Defending the Military Food Supply Acquisition, Preparation, and Protection of Food at U.S. Military Installations. Mara A, McGrath, L. Center for Technology and National Security Policy National Defense University, September 2009.
<https://apps.dtic.mil/dtic/tr/fulltext/u2/a506611.pdf>

[5] An overview of foodborne pathogen detection: in the perspective of biosensors. Velusamy V, Arshak K, Korostynska O, Oliwa K, Adley C. *Biotechnol Adv.* 2010 Mar-Apr; 28(2):232-54.

[6] Detection Methodologies for Pathogen and Toxins: A Review. Alahi MEE, Mukhopadhyay SC. *Sensors (Basel).* 2017 Aug 16; 17(8).
<https://www.mdpi.com/1424-8220/17/8/1885>

g. Keywords

Biosensor, Detector, Food, Water, Contaminant, Toxin, Pathogen, Individual, Soldier, Protection

III. SUBMISSION OF QUESTIONS

DARPA intends to use electronic mail for all correspondence regarding this SBO. Questions related to the technical aspect of the research objectives and awards specifically related to this SBO should be emailed to HR001120S0019@darpa.mil. Please reference BAA HR001120S0019-07 in the subject line. All questions must be in English and must include the name, email address, and telephone number of a point of contact.

DARPA will attempt to answer questions in a timely manner; however, questions submitted within seven (7) calendar days of the proposal due date listed herein may not be answered. DARPA will post a consolidated Frequently Asked Questions (FAQ) document. To access the posting, please visit: <http://www.darpa.mil/work-with-us/opportunities>. Under the

HR001120S0019-07 summary, there will be a link to the FAQ. The FAQ will be updated on an ongoing basis until one week prior to the proposal due date.

In addition to the FAQ specific to this SBO, proposers should also review the SBIR/STTR General FAQ list at: <http://www.darpa.mil/work-with-us/opportunities?tFilter=&oFilter=29934>. Under the HR001120S0019 summary, there is a link to the general FAQ.

Technical support for the Defense SBIR/STTR Innovation Portal (DSIP) is available Monday through Friday, 9:00 a.m. – 5:00 p.m. ET. Requests for technical support must be emailed to DoDSBIRSupport@reisystems.com with a copy to HR001120S0019@darpa.mil.